Center Innovation Fund: KSC CIF

# Method for Producing Launch/Landing Pads and Structures

Completed Technology Project (2014 - 2015)

## Project Introduction

Current plans for deep space exploration include building landing/launch pads capable of withstanding the rocket blast of much larger spacecraft that that of the Apollo days. The proposed concept will develop lightweight launch and landing pad materials from in-situ materials, utilizing regolith to produce controllable porous cast metallic foam bricks/tiles/shapes. These shapes can be utilized to lay a landing/launch platform, as a construction material or as more complex parts of mechanical assemblies.

Currently there are no methods of constructing landing/launch pads in space on an extra-terrestrial surface for Vertical Takeoff / Vertical Landing (VTVL). This means that there is a risk to the lander vehicle and crew due to rocket engine plume high pressure impingement on the regolith surface, which could cause erosion resulting in high velocity ejecta and a crater. The ability to robotically construct these pads out of in-situ materials will provide a method of mitigating the risk, decreasing the lifecycle cost and increasing the reliability of vertical take- off and vertical landing vehicles. Robotic precursor missions could use these methods to prepare a landing site by grading it and stabilizing the regolith surface with autonomously emplaced pavers made from in-situ regolith, which have structural integrity and thermal resistance sufficient to withstand the forces and very high temperatures from a chemical rocket engine plume. Ultimately this will increase the safety of the crew during space exploration arrivals and departures.

The current plans for Mars human exploration indicate that it will be necessary to build landing/launch pads capable of withstanding the rocket blast of much larger spacecraft than that of the Apollo days (20-40 metric tons landed mass). In addition, creating building materials from in-situ materials has been receiving increasing focus. To avoid having to land and launch a great distance from the focus area of exploration, methods to furnish a suitable landing area have focused on such techniques as sintering the regolith with a solar concentrator or microwave energy. The problem with these techniques is that they are very time consuming and dense materials are the result.

## Anticipated Benefits

By using in-situ materials in space, the large masses of aggregates for a concrete type of material do not need to be launched – creating a large cost savings. Launch costs to Low Earth Orbit (LEO) are typically $4K -$10K / kg and with a typical aero-assist gear ratio of 11:1 for transportation to the Mars surface from Low Earth Orbit (LEO), that would result in $44K-$110K cost savings per kg of mass launched.

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A high temperature resistant material was created using foamed basalt

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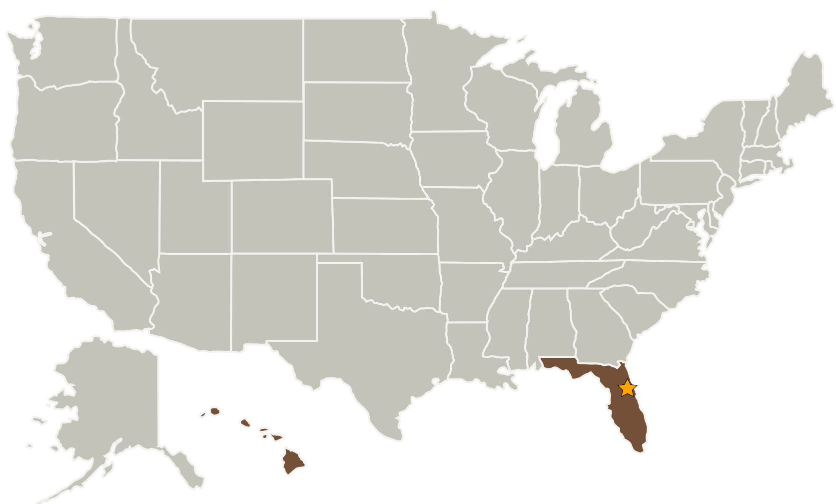
Commercial space will be routinely landing onplanetary surfaces. This technology will reduce the life cycle costs of landing pads and will reduce maintenance costs. Safety will be increased.

Space X is planning to land the first stage of terrestrial launch rockets on a landing pad. This high temperature resistant material could provide a viable solution to such activities.

The US Army and DoD could use this technology for helicopter landing pads and runways made in-situ.

### Primary U.S. Work Locations and Key Partners



## Organizational Responsibility

**Responsible Mission Directorate:**

Space Technology Mission Directorate (STMD)

**Lead Center / Facility:**

Kennedy Space Center (KSC)

**Responsible Program:**

Center Innovation Fund: KSC CIF

## Project Management

**Program Director:**

Michael R Lapointe

**Program Manager:**

Barbara L Brown

**Principal Investigator:**

Robert P Mueller

**Co-Investigator:**

Steven Trigwell

## Technology Areas

**Primary:**

- TX07 Exploration Destination Systems
  └ TX07.2 Mission Infrastructure, Sustainability, and Supportability

*Continued on following page.*

| Organizations Performing Work | Role | Type | Location |
|---|---|---|---|
| ★Kennedy Space Center(KSC) | Lead Organization | NASA Center | Kennedy Space Center, Florida |
| SCF Processing, LLC | Supporting Organization | Industry Women-Owned Small Business (WOSB) | Gainesville, Florida |

| Co-Funding Partners | Type | Location |
|---|---|---|
| Pacific International Space Center for Exploration Systems(PISCES) | US Government | Hilo, Hawaii |

| Primary U.S. Work Locations | |
|---|---|
| Florida | Hawaii |

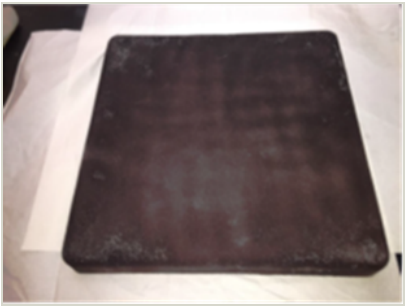
## Images


**Foamed Basalt which is very lightweight**
A high temperature resistant material was created using foamed basalt
*(https://techport.nasa.gov/image/16588)*

**Morpheus Landing at KSC Test Site**
Rocket plume shows impingement effects on the ground
*(https://techport.nasa.gov/image/16586)*

## Technology Areas *(cont.)*

└ TX07.2.2 In-Situ Manufacturing, Maintenance, and Repair



**Paver for a launch/landing pad surface**
This paver was made of sintered basalt
*(https://techport.nasa.gov/image/16587)*

## Stories

Method for Producing In-Situ Vertical Takeoff / Vertical Landing (VTVL) Pads & Structures
*(https://techport.nasa.gov/file/21788)*

Officials get look at PISCES lunar landing pad
*(https://techport.nasa.gov/file/27642)*

Paving the way to space
*(https://techport.nasa.gov/file/8781)*

PISCES Unveils Basalt Landing Pad
*(https://techport.nasa.gov/file/27641)*

## Links

KSC-13865
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KSC-13952
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